PATENT ABSTRACTS OF JAPAN

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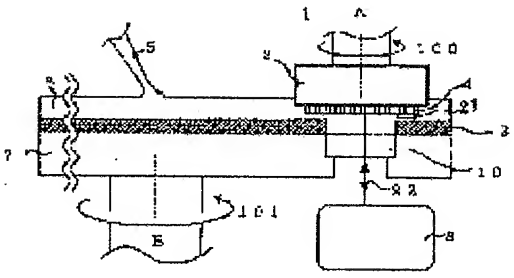
(54) POLISHING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the reflection light on the boundary surface between a detection window and abrasive liquid by providing a grinding body with at least one detection window for penetrating the measurement light and the signal light for measuring the grinding condition during the grinding.
SOLUTION: A grinding head 3 is rotated (100) on a shaft A by a proper means, and a surface plate 7 is rotated (101) on a shaft B by a proper means. During this process, a surface to be ground of a wafer 4 is ground by the action of the abrasive liquid 6 and a grinding pad 2. During the grinding, the measurement light emitted from a final point detecting device 8 penetrates through a detection window 10, penetrates through the abrasive liquid, and reaches the surface to be ground of the wafer 4, and the reflection light having the information on the surface to be ground penetrates through the abrasive liquid and the detection window 10 again as the signal light, and is detected by an optical detecting device of the final point detecting device 8. On this occasion, the detection window 10 is formed by a glass plate. The refraction factor of this glass plate is determined to be approximately same as that of the abrasive liquid.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the suitable polish device for CMP to use for flattening polish of the semiconductor device carried out in the process of manufacturing semiconductors, such as a polish device which grinds the polished surface of a polishing object, especially ULSI (large scale integration circuit).
[0002]
[Description of the Prior Art]The process of a semiconductor manufacturing process increases in connection with high integration of an integrated circuit, and minuteness making, and it is becoming complicated. The surface of a semiconductor device is becoming necessarily flat [in connection with this] less. Existence of the level difference in the surface causes the stage piece of wiring, increase of local resistance, etc., and brings about an open circuit and the fall of electric capacity. In an insulator layer, it leads also to withstand voltage degradation or generating of leak.
[0003]In connection with the light source wavelength of optical lithography becoming short in connection with high integration of an integrated circuit, and minuteness making, and on the other hand, what is called NA becoming large in the number of open lots, the depth of focus of a semiconductor aligner is becoming shallow substantially. In order to respond to the depth of focus becoming shallow, flattening on the surface of a device is demanded more than former. As a method of carrying out flattening of such a semiconductor surface, Chemical-and-mechanical-grinding (referred to as CMP from Chemical Mechanical Polishing or Chemical Mechanical Planarization, and this) art is considered to be a promising method.
[0004]CMP is developed based on the mirror-polishing method of a silicon wafer, and is performed using the device as shown in drawing 5. It is drawing 5 and, as for a polishing head and 4, a CMP polish device and 20 are [a grinding liquid feed zone and 6] grinding liquid a polishing object (wafer) and 5 a polishing body and 3 1. The polishing body 20 sticks the polishing pad 2 on the surface plate 7. As the polishing pad 2, non-foamed resin with groove structure is used for the sheet shaped thing which consists of foaming polyurethane, or the surface. The polishing head 3 is rotated focusing on the axis A by a suitable means (100), and rotates the surface plate 7 focusing on the axis B by a suitable means (101). As for the wafer 4, a polished surface is ground by operation of the grinding liquid 6 and the polishing pad 2 in this process.
[0005]Although there is a method by change of the motor torque of the vibration, the sound, the friction variation, the wafer rotation, and the rotation of a pad as a method which detects the time of specified quantity polish of the wafer surface being carried out by the above-mentioned polish process, and carrying out flattening enough, i.e., a grinding completion point, slurry analysis, etc., Optical means are beginning to attract attention from the point that especially the accuracy of measurement is high. Optical means are the methods of irradiating the polished surface of a wafer with a measuring beam, and measuring a polished surface using the optical signal penetrated or

reflected. 8 is a termination detection device and comprises a detector etc. which detect the catoptric light from the light source and wafer which emit a measuring beam. The aperture for this measuring beam to pass is provided in the surface plate 7 and the polishing pad 2, and the detection window 9 is inserted in so that the grinding liquid 6 may not flow out of an aperture. The upper surface of the detection window 9 is somewhat low in the same flat surface as the upper surface of the polishing pad 2 so that the polished surface 21 of the wafer 4 may not be contacted. After the measuring beam emitted from the termination detection device 8 penetrates the detection window 9, it is reflected by the polished surface 21 of the wafer 4, and catoptric light penetrates the detection window 9 again, returns to the termination detection device 8, and is detected with the detector of the termination detection device 8. When the polished surface by which the insulator layer is formed on the device pattern of a wafer is considered now, reflectance shows the spectral characteristic depending on the thickness of the insulator layer. The termination detection device 8 computes the thickness of an insulator layer from the spectral characteristic of this reflectance, and detects the end point of a polishing process.

[0006]

[Problem(s) to be Solved by the Invention]However, in a Prior art, it was not taken into consideration about the influence of the grinding liquid 6. When a measuring beam and an optical signal penetrate the grinding liquid 6 between the wafer 4 and the detection window 9, the interface of the detection window 9 and the grinding liquid 6 reflects a measuring beam and an optical signal. That is, reflection took place in the interface of the detection window 9 by the difference in the refractive index of the grinding liquid 6 and the detection window 9, and since it was the reflection loss, the amount of optical signals which enters into a photodetector for detection was falling. The influence of the light scattering by the abrasive grain contained in grinding liquid was not able to be disregarded, either. Abrasive grains might be scattered about in the measuring beam and the optical signal, and the scattered light might enter into the photodetector as noise light together with the optical signal. The abrasive grain absorbed the measuring beam and the optical signal, and there was a problem to which the amount of optical signals which enters into a photodetector falls.

[0007]The S/N ratio of measurement fell by a fall and noise light of the above amounts of optical signals, and it had become a cause by which the accuracy of measurement of termination detection got worse. It is making into the technical problem to provide the high termination detection machine and polish device of the accuracy of measurement which were made in order that this invention might solve the above, and solved the problem of the fall of the amount of measuring beams by reflection loss.

[0008]

[Means for Solving the Problem]In order to solve an aforementioned problem, this invention is in a state where had a polishing head and a polishing body holding "polishing object in the first place, and grinding liquid was made it to intervene between said polishing body and said polishing object, In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, Said polishing body is equipped with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass, and said detection window provides a polish device (claim 1) having a refractive index near the above-mentioned grinding liquid."

[0009]By making a refractive index of a detection window close to a refractive index of grinding liquid, this invention reduces a light volume loss by reflection of an interface, and improves a S/N ratio of measurement. The second is provided with "the polish device (claim 2) according to claim 1 which said grinding liquid carries out mixture dispersion of the abrasive grain to a solvent, changes, and is characterized by a refractive index of said solvent and a refractive index of said abrasive grain being almost equal."

[0010]By making almost equal a refractive index of a solvent, and a refractive index of an abrasive grain, this invention reduces noise light which comes from the scattered light, and improves a S/N

ratio of measurement. The third, "in the state where had a polishing head and a polishing body holding a polishing object, and grinding liquid was made to intervene between said polishing body and said polishing object. In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, Said polishing body is equipped with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass, and a polish device (claim 3) provided with a grinding liquid discharge part which eliminates said grinding liquid which intervenes between said detection window and said polishing object" is provided.

[0011]By eliminating grinding liquid over which a measuring beam is scattered, this invention reduces the scattered light by grinding liquid, and also noise light, and raises a S/N ratio of measurement. The fourth is provided with "the polish device (claim 4) according to claim 3, wherein said grinding liquid discharge part makes grinding liquid which is near the detection window with a fluid flow outside."

[0012]The fifth is provided with "the polish device (claim 5) according to claim 3, wherein said grinding liquid discharge part makes grinding liquid which is near the detection window with a gas flow outside." The sixth, "in the state where had a polishing head and a polishing body holding a polishing object, and grinding liquid was made to intervene between said polishing body and said polishing object. In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, Said polishing body is equipped with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass, and a polish device (claim 6), wherein said detection window is made from a hydrophobic material" is provided.

[0013]Since this invention does not have dispersion of a measuring beam by grinding liquid using a detection window which has a surface characteristic to which grinding liquid over which a measuring beam is scattered does not adhere, its noise light decreases and its S/N ratio of measurement improves.

[0014]

[Embodiment of the Invention]Although the embodiment of this invention is described using a figure below, this invention is not limited to this figure.

[Embodiment 1] Drawing 1 is a figure showing the polish device of the embodiment of the invention 1 (it is equivalent to claims 1 and 2). As for a polishing head and 4, 20 is [a grinding liquid feed zone and 6] grinding liquid a polishing object (wafer) and 5 a polishing body and 3. The polishing body 20 sticks the polishing pad 2 on the surface plate 7. As the polishing pad 2, whichever of non-foamed resin with groove structure may be used for the sheet shaped thing which consists of foaming polyurethane, or the surface. The polishing head 3 is rotated focusing on the axis A by a suitable means (100), and rotates the surface plate 7 focusing on the axis B by a suitable means (101). As for the wafer 4, a polished surface is ground by operation of the grinding liquid 6 and the polishing pad 2 in this process.

[0015]The measuring beam emitted from the termination detection device 8 penetrates the detection window 10 during polish, grinding liquid is penetrated, the polished surface of a wafer is reached, and the catoptric light with the information on a polished surface penetrates grinding liquid and the detection window 10 again as an optical signal, and is detected with the photodetection device of the termination detection device 8. Here, the detection window 10 comprises a glass plate. The refractive index of this glass plate is chosen so that it may become almost the same as the refractive index of grinding liquid.

[0016]Hereafter, the refractive index of grinding liquid is described. The grinding liquid used for CMP prepares an abrasive grain to a solvent, and the combination is chosen by the kind of the insulator layer and metal membrane which are polishing objects. As an abrasive grain currently generally used, there are cerium oxide (CeO_2), alumina ($aluminum_2O_3$), silica (SiO_2), etc. The refractive index of these abrasive grains is 1.55 to 2.0 in a visible range, and more generally than these abrasive grains

the refractive index of a solvent is low, and it can be considered that grinding liquid is what the abrasive grain distributed uniformly in the solvent by the polishing condition. The particle diameter of an abrasive grain is about 100 nm usually smaller enough than hundreds of nm of the wavelength of a measuring beam. At this time, it becomes transparent [grinding liquid] and it is known that that refractive index shows the middle of the refractive index of a solvent and the refractive index of an abrasive grain depending on the concentration of an abrasive grain. The refractive indicees of grinding liquid are usually 1.5-1.8 as mentioned above depending on the kind of abrasive grain, and the concentration of an abrasive grain and the kind of solvent.

[0017]In selection of the optical glass material used for the glass plate used here, cost and chemical durability other than a refractive index are taken into consideration. Although the optical glass materials used preferably are crown, heavy crown, Flint, heavy Flint, etc., if only they fulfill the above-mentioned conditions, they are not limited to these ** material in particular. For example, depending on the refractive index of grinding liquid, silica glass is also used preferably.

[0018]The with a refractive indicees of around 1.50 ** material as which the refractive index was chosen from crown system glass to the grinding liquid of 1.50 as an example of proper use of ** material is used preferably, The with a refractive indicees of around 1.60 ** material as which the refractive index was chosen from heavy crown system glass to the grinding liquid of 1.60 is used preferably, and the with a refractive indicees of around 1.80 ** material as which the refractive index was chosen from Flint system glass to the grinding liquid of 1.80 is used preferably.

[0019]Thus, the effect of using properly the ** material of the glass plate used for a detection window according to the refractive index of grinding liquid is described below. In the interface between media with a refractive index different generally, reflection of light takes place and it is known that the reflectance will change with the incidence angle to a boundary, refractive indicees, etc. For this reason, when the refractive index of both media is almost equal, the reflectance of light reflected in an interface becomes small. When the refractive index using the cerium oxide (CeO_2) abrasive grain as an example uses the grinding liquid of 1.80, according to this invention. Since the ** material of the refractive index 1.80 of the heavy Flint system near the refractive index of grinding liquid is used as a material of the glass plate of a detection window, the reflectance of light reflected in the interface of both media becomes very small, and a light volume loss is a grade which can be disregarded.

[0020]The material which penetrates measuring beams other than a glass plate, such as a plastic sheet, can be used for a detection window. As mentioned above, as for it from which the catoptric light in the interface of the solvent of grinding liquid and an abrasive grain other than the reflection loss in the interface of grinding liquid and a detection window may become a problem, the path of an abrasive grain happens, when not small enough compared with the wavelength of incident light, and this catoptric light produces light scattering. Since this scattered light enters into a photodetector together with an optical signal as noise light and reduces the S/N ratio of measurement, it is not preferred. It is preferred to select the solvent which has a refractive index near the refractive index of an abrasive grain for reduction of this catoptric light, i.e., reduction of the scattered light.

[0021]After the photodetection device of the termination detection device 8 receives an optical signal (multicomponent wavelength light) preferably on the above conditions, the termination detection device 8, Carry out the spectrum of the optical signal and The maximal value of the spectrum signal, the minimal value, or the (maximal value-minimal value), Or (the minimal value / maximal value), the maximum maximal value, or the minimum minimal value, [monitor / any which were chosen from distribution of the (maximum maximal value-minimum minimal value), (the minimum minimal value / the maximum maximal value), or a spectrum signal, or the ingredient of the suitable Fourier transform of a spectrum signal, or / or / one or more] Or measurement of a polishing condition is performed by fitting with the measured spectrum signal or its Fourier transform signal, and the spectrum signal which simulation computation was beforehand carried out and was memorized or its Fourier transform signal. The method of comparing a cross correlation

function as the method of fitting is used preferably. The important things as a concrete parameter are detection of polish thickness, and detection (termination detection) of a process end point.
[0022]Since there are few light volume losses of an optical signal since the detection window of the refractive index near grinding liquid is used as mentioned above according to this invention, and there is little dispersion, it is measurable in an optical signal with a high S/N ratio, therefore it is highly precise and detection of polish thickness and termination detection are possible.
[Embodiment 2] Drawing 2 is a figure showing the embodiment of the invention 2 (it is equivalent to claims 3 and 4), and differs in that the pure water feed zone 11 and the feed route 13 are established in Embodiment 1. The pure water feed zone 11 was provided with the tank 12 which collects pure water, and is connected with the detection window 9 through the feed route 13. Pure water flows into the detection window 9 from the pure water feed zone 11 from the relation of a pressure, and pure water is supplied to the tank 12 from the opening 14. Although the grinding liquid 6 has adhered to the detection window 9 and the wafer 4 in process of polish, it passes with the pure water supplied from this pure water feed zone 11, and grinding liquid 6 concentration becomes low. For this reason, the number of the abrasive grains which scatter about for them and absorb a measuring beam and an optical signal decreases, and the light volume detected with the termination detection device 8 increases. The S/N ratio of an optical signal improves by this, and detection of polish thickness and termination detection are more possible to high degree of accuracy.
[0023]Although pure water is supplied with the hydrostatic pressure from the tank 12 at drawing 2, the tank 12 may be made into the shape of a piston, and it may supply compulsorily, putting it. Although the pure water feed zone 11 was fixed to the surface plate 7 and pure water was supplied through the feed route 13, it may be made to only pour pure water from the detection window 9 upper surface. Although pure water is removing grinding liquid in drawing 2, it may carry out again using the solution currently used for grinding liquid.
[Embodiment 3] Drawing 3 is a figure showing the embodiment of the invention 3 (it is equivalent to claims 3 and 5). It differs in Embodiment 2 in that the air blow part 15 is formed instead of the pure water feed zone 11. The air tank 16 and the valve 17 are formed in the air blow part 15, and it is connected to the detection window 9 through the feed route 13. The inside of the air tank 16 has high voltage, and sprays air on the detection window 9. At this time, an exhaust air flow can be adjusted by the valve 17. Although the grinding liquid 6 has adhered to the detection window 9 and the wafer 4 in process of polish, the grinding liquid 6 is blown away by the air sprayed from this air blow part 15. For this reason, a measuring beam enters into the termination detection device 8, without being scattered about between the wafer 4 and the detection window 9. The S/N ratio of optical signal measurement can improve by this, therefore detection of polish thickness and termination detection can be performed with high precision.
[0024]Although exhaust air was sprayed through the feed route 13 in drawing 3, it may be made to spray from the detection window 9 upper surface. Not only air but nitrogen gas etc. can be sprayed, and the grinding liquid 6 can also be removed.
[Embodiment 4] Drawing 4 (a) is a figure showing the embodiment of the invention 4 (it is equivalent to claim 6), and is the figure which looked at the CMP device of this invention from the upper part. The surface plate 2 rotates in the direction of the arrow 101, and rotates the wafer 4 in the direction of the arrow 100. The detection window 18 for termination detection is inserted in the surface plate 2. The detection window 18 is made from a hydrophobic material, and can use the transparent plastic etc. which a measuring beam penetrates. The detection window 18 is carrying out the long and slender rectangle, turns the long side in the direction of a center of rotation of the surface plate 2 like drawing 4 (a), and is attached.
[0025]The surface plate 2 rotates in the direction of the arrow 101, and the time of the wafer 4 crossing the detection window 18 is considered. Although the grinding liquid 6 has adhered to the surface of the detection window 18, since the window material of the detection window 18 is made of a hydrophobic material, the grinding liquid 6 has become is easy to be flipped. Since it has a long

and slender form, the grinding liquid 6 which adhered according to the centrifugal force by rotation of the surface plate 2 flows out outside easily along with the detection window 18. Therefore, although grinding liquid does not adhere to a detection window, since the wafer 4 will calculate the detection window 18 surface-lapping liquid 6 if the wafer 4 comes to the detection window 18 even if it adheres, the grinding liquid 6 is removed from between the surface of the wafer 4, and the detection windows 18. For this reason, a measuring beam enters into the termination detection device 8, without also absorbing being scattered about between the wafer 4 and the detection window 18. The S/N ratio of optical signal measurement can improve by this, therefore detection of polish thickness and termination detection can be performed with high precision.

[0026]Although the detection window 18 is turned in the direction of a center of rotation and installed in drawing 4 (a), you may arrange like drawing 4 (b). In drawing 4 (b), the long and slender detection window 18 is inserted in on the concentric circle from the center of rotation of the surface plate 2. Also in this case, the grinding liquid 6 can be removed from between the wafer 4 and the detection windows 18 by the same effect as ****. By drawing 4 (a) and (b), although the plastic is used for a detection window, it can also be used besides it, being able to give the canal coat of a silicon resin system, a fluoro-resin system, or a wax system to the surfaces, such as glass and silica glass. By performing coating which flips the grinding liquid 6 on the surface of the material which a measuring beam penetrates, attenuation of the measuring beam by the grinding liquid 6 can be prevented.

[0027]As mentioned above, although Embodiments 1-4 explained this invention, the catoptric light of the field by the side of the termination detection device of the glass plate of a detection window must also be further taken into consideration here. Although it depends for this reflectance on the refractive index of the glass plate to be used, it is usually not less than several percent, and this catoptric light causes reduction of the optical signal as a light volume loss, and increase of noise light, and all reduce the S/N ratio of optical signal measurement.

[0028]In order to reduce this, it is preferred to form a multilayered antireflection film in this field by the well-known method if needed. Reflectance can be reduced substantially by this and the S/N ratio of optical signal measurement improves. In order to divert the catoptric light from the field by the side of the termination detection device of a glass plate from the optic axis of a measuring beam and to keep catoptric light from entering into the photodetection device of the termination detection device 8, let the directions of a surface normal line by the side of the termination detection device of a glass plate be an optical axis direction and non parallel. Therefore, it is also a desirable method to make a glass plate into a wedge shape. Although the method of making a glass plate a wedge shape can make the catoptric light which enters into the photodetection device of the termination detection device 8 as noise light there be nothing, it cannot reduce a light volume loss. Therefore, both methods of making an antireflection film and a glass plate a wedge shape are used together if needed.

[0029]As mentioned above, although Embodiments 1-4 explained this invention, this invention is applied to the detecting method of the surface state in the manufacturing process not only in the removal thickness in a removal process or the termination detection method of the insulating layer of the surface of a semiconductor device in a semiconductor device manufacturing process, or an electrode layer but various industries.

[0030]

[Effect of the Invention]As mentioned above, since the catoptric light in the interface of a detection window and grinding liquid can be reduced according to the embodiment of the invention 1, the quantity of an optical signal can increase, and, as a result, the S/N ratio of optical signal measurement can improve, therefore detection of polish thickness and termination detection can be performed with high precision. According to the embodiment of the invention 2, the number of the abrasive grains which scatter about for it and absorb an optical signal decreases, the amount of optical signals increases and the unnecessary scattered light decreases. The S/N ratio of an optical

signal improves by this, and detection of polish thickness and termination detection are more possible to high degree of accuracy. According to the embodiments of the invention 3 and 4, the abrasive grain which scatters about for it and absorbs an optical signal is lost, the amount of optical signals increases and the unnecessary scattered light is lost substantially. The S/N ratio of an optical signal improves by this, and detection of polish thickness and termination detection are more possible to high degree of accuracy.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1]In the state where had a polishing head and a polishing body holding a polishing object, and grinding liquid was made to intervene between said polishing body and said polishing object. In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, A polish device which equips said polishing body with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass and with which said detection window is characterized by having a refractive index near the above-mentioned grinding liquid.
[Claim 2]The polish device according to claim 1 which said grinding liquid carries out mixture dispersion of the abrasive grain to a solvent, changes, and is characterized by a refractive index of said solvent and a refractive index of said abrasive grain being almost equal.
[Claim 3]In the state where had a polishing head and a polishing body holding a polishing object, and grinding liquid was made to intervene between said polishing body and said polishing object. In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, A polish device equipping said polishing body with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass, and having a grinding liquid discharge part which eliminates said grinding liquid which intervenes between said detection window and said polishing object.
[Claim 4]The polish device according to claim 3, wherein said grinding liquid discharge part makes grinding liquid which is near the detection window with a fluid flow outside.
[Claim 5]The polish device according to claim 3, wherein said grinding liquid discharge part makes grinding liquid which is near the detection window with a gas flow outside.
[Claim 6]In the state where had a polishing head and a polishing body holding a polishing object, and grinding liquid was made to intervene between said polishing body and said polishing object. In a polish device which grinds said polishing object by carrying out relative displacement of said polishing body and said polishing object, A polish device, wherein it equips said polishing body with one or more detection windows for letting a measuring beam and an optical signal for measuring a polishing condition during said polish pass and said detection window is made from a hydrophobic material.

[Translation done.]

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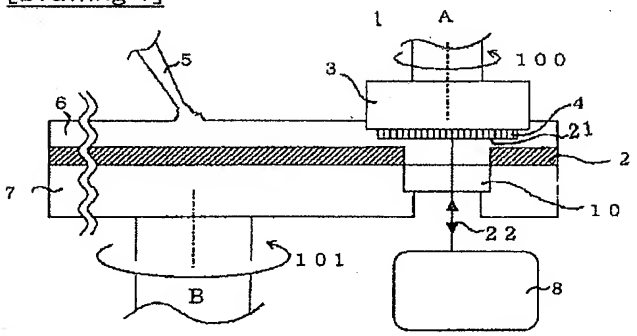
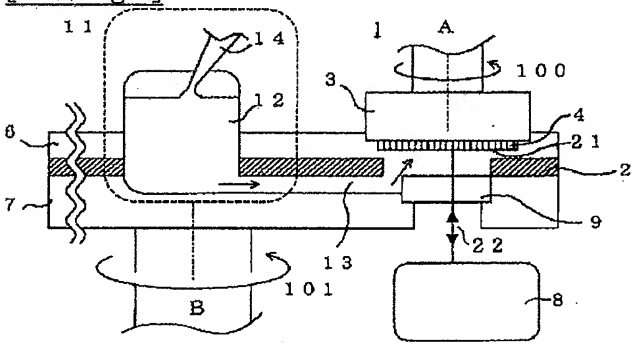
DRAWINGS

[Drawing 1]



[Drawing 2]



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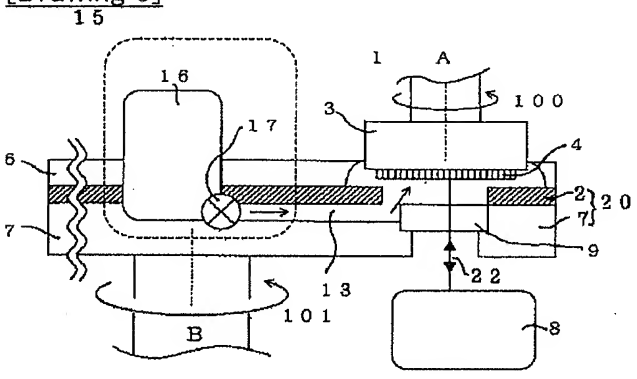
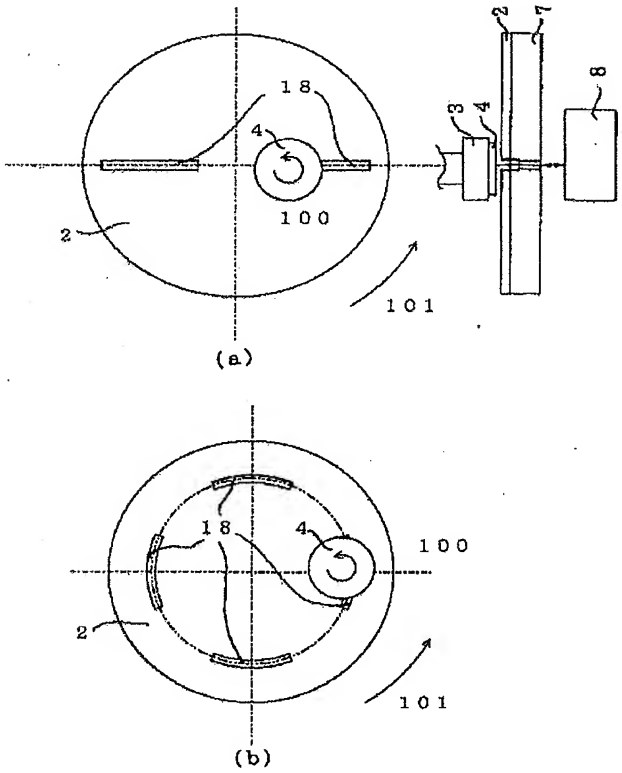
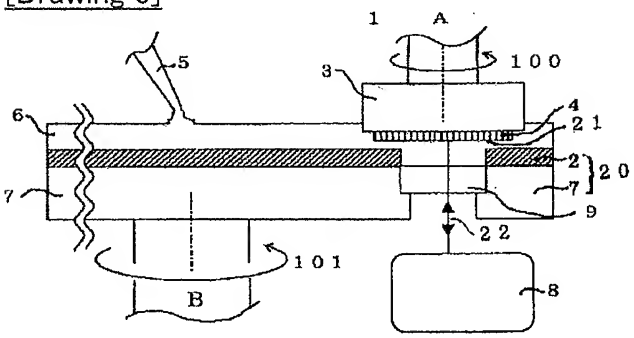


[Drawing 4]



[Drawing 5]



[Translation done.]

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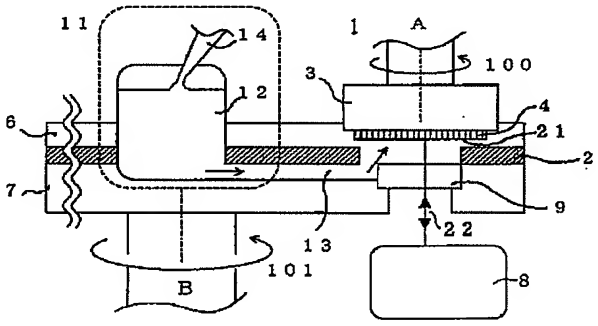
最終頁に続く

(54)【発明の名称】　研磨装置

(57)【要約】
【課題】　従来のＣＭＰ研磨装置で、光学的に研磨状態をモニターする際、研磨液６の影響について考慮されていなかった。測定光及び信号光がウェハ４と検出窓９の間の研磨液６を透過する際に、測定光及び信号光を、検出窓９と研磨液６の境界面が反射し、または砥粒が散乱し、または吸収する。そのため、光検出器に入射する信号光量が低下し、測定のＳ／Ｎ比が低下し、終点検出の測定精度が悪化する原因となっていた。
【解決手段】本研磨装置は、研磨ヘッドに保持した研磨対象物を回転運動する研磨体の表面に押し付けつつ、研磨剤を供給しながら、前記研磨対象物と前記研磨体とに相対運動を与えながら、前記研磨対象物の被研磨面を研磨し、測定光を前記被研磨面に照射して得られる信号光から研磨状態を測定し、且つ研磨体が、測定光と信号光とを透過する１個以上の検出窓を備え、尚且つ検出窓の近傍の研磨液を排除する研磨液排除部を具える。



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【特許請求の範囲】

【請求項１】研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓が上記研磨液に近い屈折率を有することを特徴とする研磨装置。

【請求項２】前記研磨液は、溶媒に砥粒を混合分散させて成り、前記溶媒の屈折率と前記砥粒の屈折率がほぼ等しいことを特徴とする、請求項１記載の研磨装置。

【請求項3 】研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓と前記研磨対象物の間に介在する前記研磨液を排除する研磨液排出部を具えることを特徴とする研磨装置。

【請求項４】前記研磨液排出部は、液体により検出窓近傍にある研磨液を外部に流出させることを特徴とする請求項３記載の研磨装置。

【請求項５】前記研磨液排出部は、気体により検出窓近傍にある研磨液を外部に流出させることを特徴とする請求項３記載の研磨装置。

【請求項６】研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓は疎水性の材料から作られていることを特徴とする研磨装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、研磨対象物の被研磨面を研磨する研磨装置、特にＵＬＳＩ（大規模集積回路）等の半導体を製造するプロセスにおいて実施される半導体デバイスの平坦化研磨に用いるのに好適なＣＭＰ用研磨装置に関するものである。

【０００２】

【従来の技術】半導体集積回路の高集積化、微細化に伴って半導体製造プロセスの工程が増加し複雑になってきている。これに伴い、半導体デバイスの表面は必ずしも平坦ではなくなってきている。表面に於ける段差の存在は配線の段切れ、局所的な抵抗の増大などを招き、断線や電気容量の低下をもたらす。また、絶縁膜では耐電圧劣化やリークの発生にもつながる。

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【０００３】一方、半導体集積回路の高集積化、微細化に伴って光リソグラフィの光源波長は短くなり、開口数いわゆるNAが大きくなってきていることに伴い、半導体露光装置の焦点深度が実質的に浅くなってきている。焦点深度が浅くなることに対応するためには、今まで以上にデバイス表面の平坦化が要求されている。このような半導体表面を平坦化する方法としては、化学的機械的研磨(Chemical Mechanical Polishing又はChemical Mechanical Planarization 、これよりCMP と呼ぶ)技術が有望な方法と考えられている。

【０００４】CMP はシリコンウェハの鏡面研磨法を基に発展しており、図５に示すような装置を用いて行われている。図５で１はCMP 研磨装置、２０は研磨体、３は研磨ヘッド、４は研磨対象物(ウェ ハ) 、５は研磨液供給部、６は研磨液である。研磨体２０は、定盤７の上に研磨パッド２を貼り付けたものである。研磨パッド２としては、発泡ポリウレタンよりなるシート状のもの、あるいは表面に溝構造を有した無発泡樹脂が使用されている。研磨ヘッド３は適当な手段により軸Ａを中心に回転運動（１００）し、また定盤７は適当な手段により軸Ｂを中心に回転運動（１０１）する。この過程でウェハ４は、研磨液６と研磨パッド２の作用により被研磨面が研磨される。

【０００５】上記研磨過程によりウェハ表面が所定量研磨され充分平坦化した時点、つまり研磨終了点を検出する方法として、振動、音響、摩擦変動、ウェハ回転やパッドの回転のモータートルクの変化、スラリー分析、等による方法があるが、特に測定精度が高い点から光学的方法が注目され始めている。光学的方法はウェハの被研磨面に測定光を照射し、被研磨面を透過または反射した信号光を利用して測定する方法である。８は終点検出装置で、測定光を出射する光源とウェハからの反射光を検出する検出器等から構成されている。定盤７および研磨パッド２にはこの測定光が通過するためのアパーチャが設けられており、研磨液６がアパーチャから流れ出ないように検出窓９がはめ込まれている。検出窓９の上面は、ウェハ４の被研磨面２１に接触しないように研磨パッド２の上面と同一平面か少し低くなっている。終点検出装置８から出射された測定光は検出窓９を透過した後、ウェハ４の被研磨面２１で反射され、反射光は再び検出窓９を透過して終点検出装置８に戻り、終点検出装置８の検出器で検出される。いま、ウェハのデバイスパターン上に絶縁膜が形成されている被研磨面を考えると、反射率は絶縁膜の膜厚に依存した分光特性を示す。終点検出装置８はこの反射率の分光特性から絶縁膜の膜厚を算出し、研磨工程の終了点を検出する。

【０００６】

【発明が解決しようとする課題】しかしながら従来の技術では研磨液６の影響については考慮されていなかった。測定光及び信号光がウェハ４と検出窓９の間の研磨

液６を透過する際に、検出窓９と研磨液６の境界面が測定光及び信号光を反射する。すなわち、研磨液６と検出窓９の屈折率の違いにより検出窓９の境界面で反射が起こり、その反射損失のため、検出のために光検出器に入射する信号光量が低下していた。更に、研磨液に含まれる砥粒による光散乱の影響も無視できなかった。砥粒が測定光及び信号光を散乱し、その散乱光が信号光と一緒にノイズ光として光検出器に入射することがあった。また更に、砥粒が測定光及び信号光を吸収し、光検出器に入射する信号光量が低下する問題があった。

【０００７】以上のような信号光量の低下とノイズ光により測定のＳ／Ｎ比が低下し、終点検出の測定精度が悪化する原因となっていた。本発明は以上を解決するためになされたものであり、反射損失による測定光量の低下の問題を解決した、測定精度の高い終点検出機および研磨装置を提供することを課題としている。

【０００８】

【課題を解決するための手段】上記課題を解決するため、本発明は第一に、「研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓が上記研磨液に近い屈折率を有することを特徴とする研磨装置（請求項１）」を提供する。

【０００９】本発明は、検出窓の屈折率を研磨液の屈折率に近くすることにより境界面の反射による光量損失を低減し、測定のＳ／Ｎ比を向上するのである。第二に、「前記研磨液は、溶媒に砥粒を混合分散させて成り、前記溶媒の屈折率と前記砥粒の屈折率がほぼ等しいことを特徴とする、請求項１記載の研磨装置（請求項２）」を提供する。

【００１０】本発明は、溶媒の屈折率と砥粒の屈折率をほぼ等しくすることにより散乱光から来るノイズ光を減らし、測定のＳ／Ｎ比を向上するのである。第三に、「研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓と前記研磨対象物の間に介在する前記研磨液を排除する研磨液排出部を具えることを特徴とする研磨装置（請求項３）」を提供する。

【００１１】本発明は、測定光を散乱させる研磨液を排除することにより研磨液による散乱光、更にはノイズ光を減らし、測定のＳ／Ｎ比を向上させるのである。第四に、「前記研磨液排出部は、液体により検出窓近傍にある研磨液を外部に流出させることを特徴とする請求項３記載の研磨装置（請求項４）」を提供する。

【００１２】第五に、「前記研磨液排出部は、気体により検出窓近傍にある研磨液を外部に流出させることを特徴とする請求項３記載の研磨装置（請求項５）」を提供する。第六に、「研磨対象物を保持する研磨ヘッドと研磨体とを具え、前記研磨体と前記研磨対象物との間に研磨液を介在させた状態で、前記研磨体と前記研磨対象物を相対移動させることにより、前記研磨対象物を研磨する研磨装置において、前記研磨中に研磨状態を測定するための測定光と信号光を通すための１個以上の検出窓を前記研磨体に具え、前記検出窓は疎水性の材料から作られていることを特徴とする研磨装置（請求項６）」を提供する。

【００１３】本発明は、測定光を散乱させる研磨液が付着しない表面特性を有する検出窓を用い、研磨液による測定光の散乱がないため、ノイズ光が減り、測定のＳ／Ｎ比が向上するのである。

【００１４】

【発明の実施の形態】以下図を用いて、本発明の実施形態を説明するが、本発明は本図に限定されるものではない。

［実施の形態１］図１は本発明の実施の形態１（請求項１、２に相当する）の研磨装置を示す図である。２０は研磨体、３は研磨ヘッド、４は研磨対象物（ウェハ）、５は研磨液供給部、６は研磨液である。研磨体２０は、定盤７の上に研磨パッド２を貼り付けたものである。研磨パッド２としては、発泡ポリウレタンよりなるシート状のもの、あるいは表面に溝構造を有した無発泡樹脂のどちらを使用しても良い。研磨ヘッド３は適当な手段により軸Ａを中心に回転運動（１００）し、また定盤７は適当な手段により軸Ｂを中心に回転運動（１０１）する。この過程でウェハ４は、研磨液６と研磨パッド２の作用により被研磨面が研磨される。

【００１５】研磨の間、終点検出装置８から出射した測定光は検出窓１０を透過し、研磨液を透過し、ウェハの被研磨面に達し、被研磨面の情報を持った反射光は信号光として再び研磨液、検出窓１０を透過し、終点検出装置８の光検出装置にて検出される。ここで、検出窓１０はガラス板から構成されている。このガラス板の屈折率は研磨液の屈折率とほぼ同じになるよう選択されている。

【００１６】以下、研磨液の屈折率について述べる。ＣＭＰに用いられている研磨液は溶媒に砥粒を調合したものであり、研磨対象である絶縁膜や金属膜の種類によりその組合せが選択される。一般的に使用されている砥粒として、酸化セリウム（CeO_2）、アルミナ（Al_2O_3）、シリカ（SiO_2）等がある。これら砥粒の屈折率は可視域で１．５５から２．０であり、溶媒は、これら砥粒よりも一般に屈折率が低く、研磨液は研磨状態

で溶媒中に砥粒が均一に分散したものと見做すことができる。砥粒の粒径は、通常は測定光の波長の数百ｎｍよりも充分に小さい１００ｎｍ程度である。このとき、研磨液は透明となり、その屈折率は、砥粒の濃度に依存し、溶媒の屈折率と砥粒の屈折率との中間を示すことが知られている。以上のように研磨液の屈折率は、砥粒の種類、砥粒の濃度、溶媒の種類に依存し、通常は１．５～１．８である。

【００１７】ここで用いるガラス板に用いる光学ガラス材料の選択に当たっては、屈折率の他に、コスト、化学的耐久性が考慮される。好ましく用いられる光学ガラス材料は、クラウン、重クラウン、フリント、重フリント等であるが、上記条件を充たしさえすれば、特にこれらの硝材に限定されるものではない。例えば、研磨液の屈折率によっては石英ガラスも好ましく使われる。

【００１８】硝材の使い分けの例としては、屈折率が１．５０の研磨液に対してはクラウン系ガラスから選ばれた屈折率１．５０前後の硝材が好ましく用いられ、屈折率が１．６０の研磨液に対しては重クラウン系ガラスから選ばれた屈折率１．６０前後の硝材が好ましく用いられ、屈折率が１．８０の研磨液に対してはフリント系ガラスから選ばれた屈折率１．８０前後の硝材が好ましく用いられる。

【００１９】このようにして検出窓に用いるガラス板の硝材を研磨液の屈折率に応じて使い分ける効果については以下に述べられる。一般に異なる屈折率を持つ媒質間の境界面では光の反射が起こり、その反射率は境界への入射角、屈折率等により変化することが知られている。このため両媒質の屈折率がほぼ等しいとき、境界面で反射される光の反射率は小さくなる。一例として、酸化セリウム（CeO_2）砥粒を用いた屈折率が１．８０の研磨液を使用する場合、本発明によれば、検出窓のガラス板の材料として、研磨液の屈折率に近い重フリント系の屈折率１．８０の硝材を用いているため、両媒質の境界面で反射される光の反射率は、極めて小さくなり、光量損失は無視できる程度である。

【００２０】なお、検出窓にはガラス板の他に、プラスチック板、等の測定光を透過する材料を使用することが出来る。以上、研磨液と検出窓との境界面での反射損失の他に、研磨液の溶媒と砥粒との境界面での反射光が問題になることがある、それは砥粒の径が入射光の波長と較べて充分に小さくない場合に起こり、この反射光は光散乱を生じる。この散乱光は、ノイズ光として、信号光と一緒に光検出器に入射し、測定のＳ／Ｎ比を低下させるので、好ましくない。この反射光の低減即ち、散乱光の低減のために、砥粒の屈折率に近い屈折率を有する溶媒を選定することが好ましい。

【００２１】以上のような条件で、終点検出装置８の光検出装置が好ましく信号光（多成分波長光）を受光したあと、終点検出装置８は、信号光を分光し、その分光信号の極大値、または極小値、または（極大値－極小値）、または（極小値／極大値）、または最大極大値、または最小極小値、または（最大極大値－最小極小値）、または（最小極小値／最大極大値）、または分光信号の分散、または分光信号の適当なフーリエ変換の成分から選ばれた何れか一つ以上をモニタすることにより、または測定された分光信号またはそのフーリエ変換信号と、予めシミュレーション計算され記憶された分光信号またはそのフーリエ変換信号とのフイッティングにより研磨状態の測定が行われる。フィッティングの方法としては相互相関係数を比較する方法が好ましく用いられる。具体的な測定項目として重要なものは、研磨膜厚の検出、工程終了点の検出（終点検出）である。

【００２２】以上のように本発明によれば、研磨液に近い屈折率の検出窓を用いているので、信号光の光量損失が少なく、且つ散乱が少ないので、高いＳ／Ｎ比で信号光を測定可能であり、従って高精度で研磨膜厚の検出、終点検出が可能である。

［実施の形態２］図２は本発明の実施の形態２（請求項３、４に相当する）を示す図で、実施の形態１とは純水供給部１１と供給経路１３とが設けられている点で異なっている。純水供給部１１は純水をためるタンク１２を具え、供給経路１３を通して検出窓９とつながっている。圧力の関係から純水供給部１１から検出窓９へ純水は流れ、タンク１２へは補給口１４から純水が補給される。研磨の過程で検出窓９およびウェハ４には研磨液６が付着しているが、この純水供給部１１から供給される純水により流され研磨液６濃度は低くなる。このため測定光及び信号光を散乱・吸収する砥粒の数は少なくなり、終点検出装置８で検出される光量は増大する。これにより信号光のＳ／Ｎ比が向上し、より高精度に研磨膜厚の検出、終点検出が可能である。

【００２３】図２ではタンク１２からの静水圧で純水を供給しているが、タンク１２をピストン状にして強制的に圧力をかけて供給しても良い。また、純水供給部１１を定盤７に固定し供給経路１３を通して純水を供給していたが、単に検出窓９上面から純水を流すようにしても良い。更にまた、図２では研磨液の除去を純水により行っているが、研磨液に使用している溶液を使用して行っても良い。

［実施の形態３］図３は本発明の実施の形態３（請求項３、５に相当する）を示す図である。実施の形態２とは純水供給部１１の替わりにエアブロー部１５が設けられている点で異なっている。エアブロー部１５にはエアタンク１６とバルブ１７が設けられており、供給経路１３を通して検出窓９へつながっている。エアタンク１６内は高圧になっており、検出窓９へ空気を吹き付ける。このときバルブ１７でエア流量を調節することが出来る。研磨の過程で検出窓９およびウェハ４には研磨液６が付着しているが、このエアブロー部１５から吹き付けられ

る空気により研磨液６は吹き飛ばされる。このため測定光はウェハ４と検出窓９の間で散乱されることなく終点検出装置８に入射する。これにより信号光測定のＳ／Ｎ比が向上し、従って高精度に研磨膜厚の検出、終点検出を行うことが出来る。

【００２４】図３では供給経路１３を通してエアを吹き付けていたが、検出窓９上面から吹き付けるようにしても良い。また空気に限らず窒素ガス等を吹き付けて研磨液６を除去することもできる。

［実施の形態４］図4 （ａ）は本発明の実施の形態４（請求項６に相当する）を示す図で、本発明のＣＭＰ装置を上部から見た図である。定盤２は矢印１０１の方向に回転し、ウェハ４は矢印１００の方向に回転する。定盤２には終点検出用の検出窓１８がはめ込まれている。検出窓１８は疎水性の材料から作られており、測定光が透過する透明なプラスティックなどを使用する事が出来る。検出窓１８は細長い長方形をしており、図４（ａ）のようにその長辺を定盤２の回転中心方向に向けて取り付けられている。

【００２５】定盤２が矢印１０１の方向に回転し、ウェハ４が検出窓１８を横切る時を考える。検出窓１８の表面には研磨液６が付着しているが、検出窓１８の窓材は疎水性の材料で出来ているため研磨液６が弾かれ易くなっている。更に細長い形をしているため、定盤２の回転による遠心力により付着した研磨液６は検出窓１８に沿って外側に流れ出易くなっている。そのため、検出窓には研磨液は付着しないが、仮に付着しても、ウェハ４が検出窓１８に差し掛かると、ウェハ４は検出窓１８表面の研磨液６を弾き出すので、ウェハ４の表面と検出窓１８の間から研磨液６は取り除かれる。このため測定光はウェハ４と検出窓１８の間で散乱されることも吸収されることもなく終点検出装置８に入射する。これにより信号光測定のＳ／Ｎ比が向上し、従って高精度に研磨膜厚の検出、終点検出を行うことが出来る。

【００２６】図４（ａ）では検出窓１８を回転中心方向に向けて設置しているが、図４（ｂ）の様に配置しても構わない。図４（ｂ）では、定盤２の回転中心から同心円上に細長い検出窓１８をはめ込んである。この場合も上述と同様の効果により、ウェハ４と検出窓１８の間から研磨液６を取り除くことができる。図４（ａ）、（ｂ）では検出窓にプラスティックを使用しているが、それ以外にもガラスや石英ガラス等の表面にシリコン樹脂系、フッ素樹脂系、またはワックス系の疎水コートを施して使用する事も出来る。測定光が透過する材料の表面に研磨液６を弾くコーティングを施す事で、研磨液６による測定光の減衰を防ぐ事が出来る。

【００２７】以上、実施の形態１～４により本発明を説明したが、ここで更に検出窓のガラス板の終点検出装置側の面の反射光も考慮しなければならない。この反射率は使用するガラス板の屈折率に依存するが、通常数％以上であり、この反射光は光量損失としての信号光の減少、ノイズ光の増大を起こし、何れも信号光測定のＳ／Ｎ比を低下させる。

【００２８】これを低減するため、必要に応じてこの面には周知の方法で多層反射防止膜を形成することが好ましい。これにより反射率を大幅に低減させることができ、信号光測定のＳ／Ｎ比が向上する。また、ガラス板の終点検出装置側の面からの反射光を測定光の光軸から逸らして、反射光が終点検出装置８の光検出装置に入射しないようにするために、ガラス板の終点検出装置側の面法線方向を光軸方向と非平行とする。そのためにガラス板を楔状にすることも好ましい方法である。ガラス板を楔状にする方法は、ノイズ光として終点検出装置８の光検出装置に入射する反射光を皆無にすることはできるが、光量損失を低減することはできない。そのため、必要に応じて、反射防止膜とガラス板を楔状にする方法の両方が併用される。

【００２９】以上、実施の形態１～４により本発明を説明したが、本発明は、半導体装置製造工程における、半導体素子の表面の絶縁層あるいは電極層の除去工程における除去膜厚または終点検出方法のみならず、各種産業における製造工程に於ける表面状態の検出方法に適用される。

【００３０】

【発明の効果】以上、本発明の実施の形態１によれば、検出窓と研磨液の境界面に於ける反射光を低減できるので、信号光の量が増加し、その結果、信号光測定のＳ／Ｎ比が向上し、従って、高精度に研磨膜厚の検出、終点検出を行うことが出来る。本発明の実施の形態２によれば、信号光を散乱・吸収する砥粒の数は少なくなり、信号光量は増大し、且つ不要な散乱光は低減する。これにより信号光のＳ／Ｎ比が向上し、より高精度に研磨膜厚の検出、終点検出が可能である。本発明の実施の形態３、４によれば、信号光を散乱・吸収する砥粒がなくなり、信号光量は増大し、且つ不要な散乱光は実質的になくなる。これにより信号光のＳ／Ｎ比が向上し、より高精度に研磨膜厚の検出、終点検出が可能である。

【図面の簡単な説明】

【図１】本発明の実施の形態１のＣＭＰ研磨装置を表す概念図である。

【図２】本発明の実施の形態２のＣＭＰ研磨装置を表す概念図である。

【図３】本発明の実施の形態３のＣＭＰ研磨装置を表す概念図である。

【図４】（ａ）、（ｂ）本発明の実施の形態４のＣＭＰ研磨装置を表す概念図である。

【図５】従来のＣＭＰ研磨装置を示す図である。

【符号の説明】

１　研磨ヘッド部

２　研磨パッド

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3　研磨ヘッド
4　ウェハ
5　研磨液供給部
6　研磨液
7　定盤
8　終点検出装置
9　検出窓
１０　検出窓
１１　純水供給装置
１２　タンク

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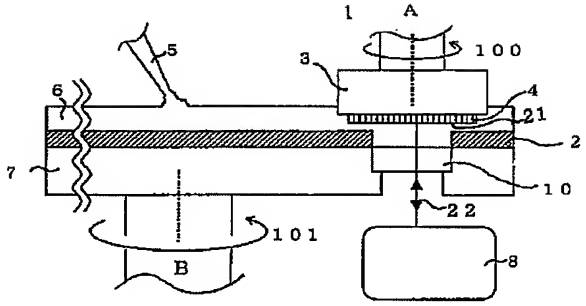
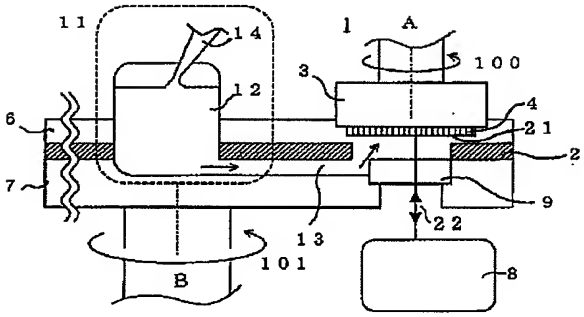
＊１３　供給経路
１４　補給口
１５　エアブロー部
１６　エアタンク
１７　バルブ
１８　検出窓
２０　研磨体
２１　被研磨面
２２　測定光と反射光（信号光）
＊10

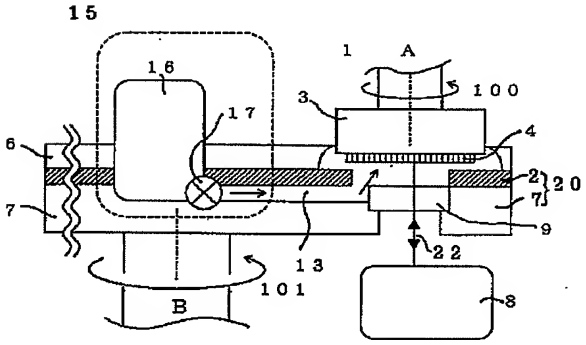
【図１】



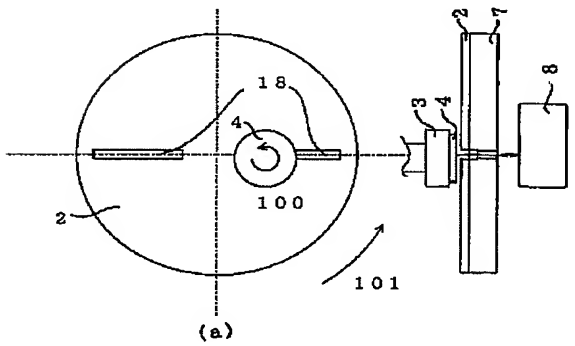
【図２】



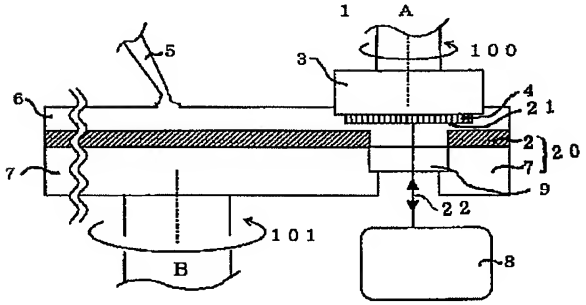
【図３】

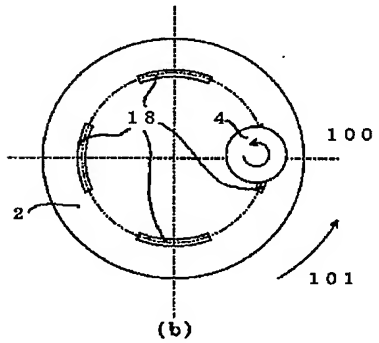


【図４】



【図５】





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